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ABSTRACT

This packet attempts to provide educationally sound alternatives to dissection in the classroom, thereby making it possible for teachers to eliminate dissection from the curriculum. This packet can also be used by educators who include dissection in their curricula but consider it important to respect the expression of students' ethical, moral, or religious concerns about the treatment of animals. This packet contains teaching activities, student activity sheets, a resources list, and an appendix of further information which includes guidelines for the study of animals in elementary and secondary school biology. Suggested teaching activities include an in-class anatomy quiz show, in-class observation of animals, a design-a-species activity, model building, computer-simulated dissection, flower dissection which gives hands-on experience with real tissue, group exploration of human muscle function and reflexes, naturalistic observation, and a veterinary field trip. A list of traditional objectives cited for the advantages to dissection is also included. These objectives are keyed towards the teaching activities to demonstrate which activities address the same objectives. (PVD)



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# ALTERNATIVES TO DISSECTION

PUBLISHED BY THE HUMANE SOCIETY OF THE UNITED STATES
YOUTH EDUCATION DIVISION

# ALTERNATIVES TO DISSECTION

## Introduction

This packet has been developed by the Youth Education Division of The Humane Society of the United States (HSUS) to provide you with educationally sound alternatives to dissection in the classroom, thereby making it possible for you to eliminate dissection from your curriculum. By providing alternative activities, this packet can also be used by educators who include dissection in their curricula yet consider it important to respect the expression of students' ethical, moral, or religious concerns about the treatment of animals. Enclosed you will find teaching activities, student activity sheets, resources, and an appendix of useful information, including guidelines for the study of animals in elementary- and secondary-school biology.

The enclosed materials demonstrate that alternatives to dissection and to invasive experiments in the classroom can be supported on both ethical and educational grounds. Increasingly, educators are recognizing that the traditional goals of such procedures do not necessitate the taking of animal life or the infliction of pain or stress on sentient beings. In addition, recent research has begun to call into question the educational value of dissection versus other, noninvasive learning activities. (See the enclosed list of comparative studies.) Indeed, many biology teachers believe that dissection activities actually distract students from learning the facts and concepts that the activities were designed to convey.

There is also a growing concern that students are choosing not to participate in science programs because of dissection requirements. Many students fear that their ethical concerns will be perceived as "squeamishness." Other students suppress their concerns by developing a callous, use-oriented attitude toward other living creatures in order to fulfill course dissection requirements. Such an attitude is at odds with the goals of biology programs that are designed to help students develop respect and appreciation for the natural world.

We encourage you to read the enclosed materials and contact The HSUS Youth Education Division if you would like further information.

Thank you for your consideration and willingness to accommodate the ethical concerns of your students—concerns that you, too, may share. We are confident that you will find the use of these alternatives to be good science and good teaching.

### Traditional Objectives to Dissection

**Skill objectives:**

- hands-on experience with real tissue
- manual dexterity
- objective description, collection and analysis of data, reporting
- overcoming squeamishness
- quantitative skills, e.g., measurement
- critical thinking, qualitative interpretation

**Content objectives:**

- knowledge of comparative, structural, and functional anatomy
- knowledge of basic principles of biology, such as life cycles, reproduction, and nutrition

**Additional objectives of animal study that should be considered:**

- knowledge of the relationship among anatomical structure, function, and environmental conditions
- consideration of ethical issues involving the use of animals in scientific research and for educational purposes
- knowledge of animal behavior and social patterns
- ✔ scientific hypothesis testing

*Alternatives to Dissection*, 2nd edition: Editors: Bill DeRosa, Lesia Winiarskyj. Contributing Editor: Jonathan Balcombe, Ph.D. Photo Editor: Cynthia Stone. Designer: Deborah Prater.

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## ANATOMICAL OVERLAYS

**Objectives:**

- objective description, collection and analysis of data, reporting
- knowledge of comparative, structural, and functional anatomy
- quantitative skills, e.g., measurement

Using projection transparencies, students create and study anatomical overlays that depict, in three-dimensional form, the anatomy of a frog's (or other animal's) body. Textbooks should be consulted for pictorial and written descriptions of external and internal anatomy. (For further instructions to students, see the Student Activity Sheet for this project, enclosed in this packet.)

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## ANATOMY QUIZ SHOW

**Objectives:**

- knowledge of basic principles of biology, such as life cycles, reproduction, and nutrition
- knowledge of comparative, structural, and functional anatomy
- knowledge of the relationships among anatomical structure, function, and environmental conditions

Students design questions testing one another's knowledge of anatomical and physiological principles, using the format of popular quiz programs such as *Wheel of Fortune* or *Jeopardy*. Questions can be used to evaluate mastery of a variety of concepts, including physical structure, function, and comparisons between and among species.

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## IN-CLASS OBSERVATION OF ANIMALS

**Objectives:**

- objective description, collection and analysis of data, reporting
- overcoming squeamishness
- knowledge of basic principles of biology, such as life cycles, reproduction, and nutrition
- knowledge of comparative, structural, and functional anatomy
- knowledge of the relationships among anatomical structure, function, and environmental conditions
- knowledge of animal behavior and social patterns
- scientific hypothesis testing
- critical thinking, qualitative interpretation
- consideration of ethical issues involving the use of animals in scientific research and for educational purposes

Through in-class observation, students can examine the external anatomy, behavior, and living patterns of animals, including ways that animals eat, communicate, groom themselves, interact with other organisms, and respond to environmental factors such as moisture, light, and changes in temperature. Based on their observations, students can infer how various physical characteristics and behavioral responses of the animals studied reflect adaptations to their environment. They can draw inferences, for example, about how animals regulate their internal environment in response to natural changes in their external environment. In-class observations, as well as observations of wild animals in their natural habitats, communicate valuable information not readily provided by text, lectures, or photographs. Freshwater fish, small pet mammals, and invertebrates are the preferred animals for in-class observational study.

J. Dommers

For guidelines on studying animals in the classroom, refer to the enclosed "HSUS Guidelines for the Study of Animals in Elementary and Secondary School Biology." In addition, have students consider some of the factors mentioned in "Naturalistic Observation," also in this packet.

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## DESIGN A SPECIES

**Objectives:**

- manual dexterity
- objective description, collection and analysis of data, reporting
- quantitative skills, e.g., measurement
- critical thinking, qualitative interpretation
- knowledge of comparative, structural, and functional anatomy
- knowledge of the relationships among anatomical structure, function, and environmental conditions
- knowledge of animal behavior and social patterns

Assign students a particular kind of habitat and have them select a taxonomic class of animal, e.g., bird, reptile, insect, mammal. Then have students—by way of written descriptions, illustrations, or three-dimensional models made of clay or wood—"design" a species that would be physically and behaviorally suited to the selected environment. For example, a possible assignment might be to design a bird that is suited to a high desert environment. Guide students in considering the following: How long is the bird's wingspan? What does the bird eat? What is the shape of its beak? What materials does it use to build its nest? How high from or low to the ground is its nesting site, and how large is its nest? How does the bird protect itself from predators?

Students should consider all of the environmental factors that will shape the physical and behavioral makeup of their species. Such factors include climate, availability and type of food, geography and terrain, availability of water, existence of predators, and so forth. Students should be able to justify their animals' anatomy on the basis of these and other environmental factors.

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## BUILD A MODEL

**Objectives:**

- manual dexterity
- objective description, collection and analysis of data, reporting
- quantitative skills, e.g., measurement
- knowiedge of comparative, structural, and functional anatomy

Using modeling clay, students construct models of a frog (or other animal), detailing both external and internal anatomy. A textbook may be used to provide pictorial and written anatomical descriptions. (For further instructions to students, see the Student Activity Sheet for this project, enclosed in this packet.)

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## COMPUTER-SIMULATED DISSECTION

**Objective:**

- knowledge of comparative, structural, and functional anatomy

Students complete a computer-simulated dissection using one of the software packages currently available. Interactive video, using graphics or digitized photographs of animals, allows students to electronically "dissect" on a computer. For information on available software, consult the list of resources included in this packet.

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## FLOWER DISSECTION

**Objectives:**

- hands-on experience with real tissue
- manual dexterity
- objective description, collection and analysis of data, reporting
- quantitative skills, e.g., measurement

Students perform dissections of flowers or other plants. Each dissection should include identification and labeling of structures, with explanations of their functions. Instruction on the proper use of dissection instruments and other laboratory apparatuses may be necessary. (For further instructions to students, see the Student Activity Sheet for this project, enclosed in this packet.)

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## HUMAN MUSCLE FUNCTION

**Objectives:**

- hands-on experience with real tissue
- objective description, collection and analysis of data, reporting
- knowledge of comparative, structural, and functional anatomy
- knowledge of the relationships among anatomical structure, function, and environmental conditions
- critical thinking, qualitative interpretation
- ✔ scientific hypothesis testing

Students work in pairs or in groups of three, with one student in each unit acting as an experimental subject, while the other(s) apply resistance and palpate the muscles being tested.

**Experiments:**

• To demonstrate the differences among types of arm movements, the subject should alternately flex and extend the elbow joint and rotate the shoulder joint.

• To demonstrate the effects of repeated movements, the subject should extend one arm at a 90° angle, palm up, and make a fist as often as possible, while another group member counts the contractions for two minutes. Without resting, the subject should continue the procedure for an additional two minutes, while the other counts. Students should then compare the frequency of contractions in the first and second trials.

**Activities for further study:**

• Using their knowledge of red and white muscle function, students can draw inferences about which muscle fiber would show greater performance abilities in different sports or physical activities.

• To study human muscle function in depth, students may use laboratory apparatuses, such as a standard kymograph or ergograph. In addition, a variety of films, videos, databases, and computer tutorials on the muscular systems of humans and frogs are available. For more information, consult the list of resources included in this packet.

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## HUMAN REFLEXES

**Objectives:**

- hands-on experience with real tissue
- objective description, collection and analysis of data, reporting
- knowledge of comparative, structural, and functional anatomy
- knowledge of the relationships among anatomical structure, function, and environmental conditions
- critical thinking, qualitative interpretation
- ✔ scientific hypothesis testing

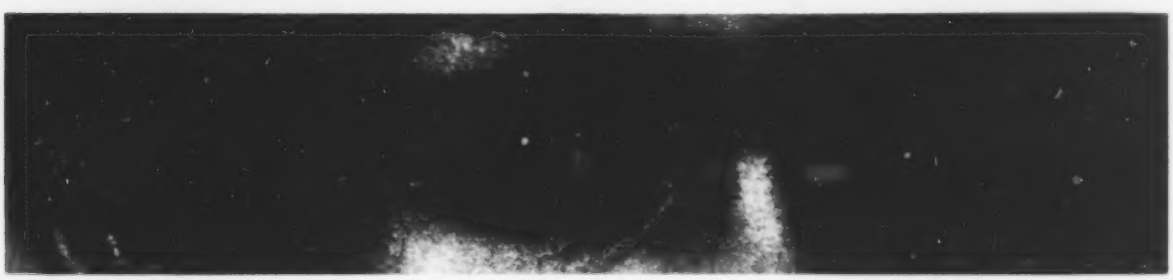
Students should study diagrams and films of the nerve impulse to learn about the reflex arc, a basic pathway in the nervous system. Students can then investigate several examples of human reflexes, recording their observations and comparing results.

**Experiments:**

• Working in pairs, students can observe how the pupil of the human eye responds to direct light. Partners should take turns comparing pupil size in diffused, indirect light (such as that in a classroom) versus under direct, bright light (such as that from a flashlight or penlight). To study the consensual light reflex, one partner holds a book (as a partition) between his or her left and right eyes, while the other student illuminates one eye and compares the sizes of the left and right pupils.

• The knee-jerk reflex can be elicited by having one partner sit cross-legged in a chair. With a reflex hammer, tap the patella tendon. Repeat for the other leg. Further examine the knee-jerk reflex by testing under varying conditions, such as following strenuous exercise or during concetrated mental activity.

• To study the plantar reflex, the subject should remove one sock and shoe. The partner should scratch the sole of the subject's foot with a blunt object from heel to toe.



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## NATURALISTIC OBSERVATION

**Objectives:**

- objective description, collection and analysis of data, reporting
- knowledge of basic principles of biology, such as life cycles, reproduction, and nutrition
- knowledge of comparative, structural, and functional anatomy
- knowledge of the relationships among anatomical structure, function, and environmental conditions
- knowledge of animal behavior and social patterns
- critical thinking, qualitative interpretation
- scientific hypothesis testing

Students observe, without disturbing, an animal in its natural habitat. Birds are often the most readily available animals for this activity. Observations can take place at school or at places such as a nature center, park, wildlife refuge, or wildlife rehabilitation center. Have students record observations of physical and behavioral traits, including size, color, feeding behavior, social interaction with members of the same or other species, appearance in relation to members of the same species, protection behavior, flight distance, and so on. Students should pay specific attention to characteristics that are particularly adaptive to the habitat. A thorough description of the habitat should be included in students' reports. Students can also include one or more hypotheses to explain a particular behavior observed.

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## PRECISION LEARNING

**Objective:**

- knowledge of comparative, structural, and functional anatomy

Students label anatomical diagrams or drawings, progressing from labeling with a list of answers from which to choose (open book) to labeling without a list (closed book). Labeling exercises can be timed or untimed.

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## VETERINARY FIELD TRIP

**Objectives:**

- hands-on experience with real tissue
- manual dexterity
- objective description, collection and analysis of data, reporting
- overcoming squeamishness
- knowledge of comparative, structural, and functional anatomy

Many teachers have found veterinary field trips to be beneficial, especially if students can observe a veterinarian performing an operation. (Note: The surgery observed should, of course, be a part of the veterinarian's regular caseload, not an unnecessary procedure scheduled for the benefit of students. Most veterinarians will want to obtain prior permission from the animal's owner.) Students should record their observations. Tissue removed from the animal during surgery could be examined by students under the supervision of the veterinarian or examined later in the classroom. Students can then write reports detailing the observations they made during the procedure and on subsequent examination of removed organs or tissue.

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## SCIENTIFIC ETHICS

**Objectives:**

- consideration of ethical issues involving the use of animals in scientific research and for educational purposes
- critical thinking

**Activities:**

• Have students critique the National Science Teachers Association's "Guidelines for Responsible Use of Animals in the Classroom." A copy of the position statement can be obtained by writing to the NSTA, 1840 Wilson Boulevard, Arlington, VA 22201. Ask students to state whether they agree or disagree with the NSTA's guidelines and provide reasons supporting their positions.

• Have students survey current newspaper and magazine articles on topics related to scientific ethics. Such topics include organ transplants, euthanasia, in-vitro fertilization, sterilization, use of animals in scientific research and in medicine, genetic engineering, and others. Ask each student to select one topic and draft a position paper or present an oral report relating the facts involved, explaining public policy with regard to the issue, and presenting arguments on both sides of the issue. Students should also state their own personal stance on the issues they have researched. You may wish to videotape an organized debate among students or invite a guest lecturer to your classroom to speak about one of the topics.

• Assign students a written or oral report delineating the pros and cons of dissection as an educational tool. Students should include a section explaining the rationale behind their personal stance on dissection.

• Using newspaper, magazine, and journal articles, students can explore the availability of alternatives to the use of animals in scientific research and commercial testing. Materials published by animal-protection groups will also be helpful. Students' findings should be presented in written or oral reports which address the following questions: Is adequate research on alternatives being conducted? Is there any evidence of unnecessary experimentation on animals? Should the use of animals in research be eliminated, even if there are no alternatives for every procedure currently being conducted? Why or why not?

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## *Student Activity Sheet:* ANATOMICAL OVERLAYS

***Note to teacher:*** *This lesson is one of a series of suggested projects for students who object to dissecting animals. One alternative to dissection is to create and study anatomical overlays. This involves making a series of drawings on transparent sheets and overlaying sheets to represent the three-dimensional organization of animal anatomy. Though the subject of this activity is a frog, anatomical overlays may be used to study other animals as well.*

Name _____

**OBJECTIVE:**

To identify the external and internal anatomy of frogs

**MATERIALS:**

*A minimum of ten projection transparencies.* Projection transparencies may be obtained through the school bookstore, teaching staff, or an office supply store. Students may also purchase Labelon Projection Transparencies from the Labelon Corporation, (800) 428-5566. The bio-LOGICAL™ frog overlay model is available through National Teaching Aids, 1845 Highland Avenue, New Hyde Park, NY 11040, (516) 326-2555.

*Water-based overhead projector pens in a minimum of six assorted colors.* Fine-point pens work best for detailed illustrations. These are available from sources that sell transparencies. The Sanford Corporation, 2711 Washington Boulevard, Bellwood, IL 60104, (708) 547-6650, supplies Vis-A-Vis pens singly and in packs of eight assorted colors.

*Reference books that provide pictorial representations and written descriptions of a frog's external and internal anatomy.* These should be available at the school or public library, or from the school's biology department. Also refer to the list of suggested resource books included in this packet.

**METHODS:**

Using a picture atlas or dissection manual, draw or trace the following views onto transparencies and shade organs appropriately. (Any of a variety of labeling techniques may be employed.)

**External view.** Create a dorsal view of the frog that demonstrates the frog's external anatomical characteristics. The following are structures that should be included: limbs, webs, digits, adhesive pad (male), brow spot, tympanum, chromatophores, eyes and ancillary structures, and nares.

**Anterior view.** This should represent an open-mouth view of the frog with the following structures properly identified: tongue, teeth, eustachian tube, glottis, nares, jaws, esophagus opening, and vocal sac openings.

**Internal view.** Five separate transparencies will be created and overlayed to illustrate the internal anatomy of a frog. The first drawing should be an outline of the frog's body from the ventral perspective, with all four limbs extended. The second transparency should include the lungs, kidneys, and arterial system of the frog, with emphasis on major arteries only. The third transparency should depict the primary veins of the venous system. Fourth is the digestive-excretory system. The fifth transparency in the internal series should illustrate the female frog's reproductive system. You may wish to illustrate one ovary with a mature egg mass on one side, with the contralateral side depicting an undeveloped ovarian structure. Due to the number of organs in these systems, you may wish to display each transparency independently first; then, as part of the collection.

**Heart.** Create a transparency that represents, in detail, the frog's unique three-chambered heart. This independent drawing should identify the three chambers and illustrate the flow of blood into and out of each chamber. The most appropriate view may be the dorsal view of the ventral half of the heart, in longitudinal section.

**EVALUATION:**

Be prepared to take the same written or oral examination as will your classmates who dissected frogs. If the examination involves actual frogs and you object to participating, be prepared to take a comparable exam, such as one that involves plastic models.

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## *Student Activity Sheet:* BUILD A MODEL

***Note to teacher:*** *This lesson is one of a series of suggested projects for students who object to dissecting animals. One alternative to dissection is to create and study clay models of animals. This involves the sculpturing of clay models that represent the three-dimensional organization of animal anatomy. Though the subject of this activity is a frog, clay modeling may be used to study other animals as well.*

Name _____

**OBJECTIVE:**

To identify the external and internal anatomy of a frog

**MATERIALS:**

*Modeling clay to represent two frog forms.* Della Robbia Miracle Clay is available at most art supply stores. This clay is generally sold in 3.5-lb. packages and can be dried to a hard, durable state in a conventional oven.

*One 12" x 12" flat surface on which to work and cast models.*

*A paintbrush and at least six colors of modeling paint, as well as a sculpting tool.* Supplies may be available through the school's art department or a local hobby/crafts shop.

*Reference books that provide pictorial representations and written descriptions of a frog's external and internal anatomy.* These should be available at the school or public library, or from the school's biology department. Also refer to the list of suggested resource books included in this packet.

**METHODS:**

Model size is optional; however, models should be large enough to enable you to work comfortably and to depict external and internal gross anatomy.

**External anatomy.** The frog should be modeled in a natural or prostrate position to clearly demonstrate limbs, digits, webs, eyes, nares, and tympanum. The mouth should be open and the point of attachment of the tongue shown. After the model has dried, paint the chromatophores on the skin surface. Also paint any other external features you wish to highlight.

**Internal anatomy.** The frog should be modeled in a supine position with the abdominal and chest cavities hollowed out. You may wish to model organs together (i.e., heart and lungs; stomach and intestines; kidneys and bladder). This will aid in demonstrating the organization and interrelationships of the various organs. After the clay has dried, you may color the organs or organ systems for added effect.

**EVALUATION:**

Be prepared to take the same written or oral examination as will your classmates who dissected frogs. If the examination involves actual frogs and you object to participating, be prepared to take a comparable exam, such as one that involves plastic models.

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## *Student Activity Sheet:* FLOWER DISSECTION

***Note to teacher:*** *This lesson is one of a series of suggested projects for students who object to dissecting animals. One valuable alternative is flower dissection. Students can examine the internal and external anatomy of a variety of flowers, gaining hands-on experience with real tissue and developing the important skills of observation and analysis.*

Name _____

**OBJECTIVES:**

To identify the internal and external anatomy of a flower

To develop skills in dissecting fresh tissues

**MATERIALS:**

*Day lily blossoms and a variety of other fresh flowers* (e.g., gladioluses, roses, poinsettias, peas, sunflowers, snapdragons).

*Dissecting tools, including scalpel, blunt probes, magnifying glass, petri dishes, glass slides, drawing materials, and dissecting microscope.*

*Botany reference books and field guides.* Consult the list of suggested resource books included in this packet.

**METHODS:**

Begin by dissecting a large, simple flower, such as a day lily.

**External anatomy.** By examining the external anatomy of the flower, illustrate and identify anatomical parts, including petals, sepals, stigma, and anthers. By counting petals and sepals, you can determine whether the plant is a monocot or a dicot. Observe the external anatomy of the anthers and stigma and speculate on the flower's mechanisms of pollination (e.g., wind, butterflies, bees) and on how the flower structure is adapted to encourage pollination.

**Internal anatomy.** Remove an anther and observe the structure of pollen grains under a dissecting microscope. Why should a plant produce so many pollen grains? Can you see anything about the structure of a grain that may affect pollination? The flower's ovary should also be removed, sliced with a scalpel to expose the ovules inside, and observed under the scope. After pollen grains land on a stigma, how do male cells reach the ovules? Can you predict the number and arrangement of seeds produced by this flower?

Examine a variety of flowers, including wild and cultivated specimens. Possible activities include:

**Flower classification.** Without using a reference text, develop a system for organizing flower types, based on internal and external anatomy. Compare your system with those that other students and botanists have created to classify the same flowers.

**Connecting flowers to seeds.** Dissect flowers that have large ovules. These include lilies, irises, and poppies. Speculate on the number and arrangement of seeds that they would produce. Observe over several days how live plants produce seeds. (Dandelions are usually readily available specimens.) Also examine a variety of fruits, such as tomatoes, apples, and strawberries. What can you infer about the types of flowers that produced the seeds and fruits?

**The wild and the tame.** Compare flowers of garden plants with blossoms of wild relatives. How have horticulturists changed the wild rose, for example? How do induced changes affect the reproduction and health of plants? How do humans help cultivated plants thrive, and how are wild plants adapted to survival without human intervention?

**EVALUATION:**

Be prepared to identify a wide variety of anatomical structures in the various plant species you dissected and to explain the functions of these to your instructor.

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# COMPARATIVE STUDIES OF DISSECTION AND OTHER ANIMAL USES IN EDUCATION

**Compiled by Jonathan Balcombe, Ph.D.**
**The Humane Society of the United States**

Fawver, A.L., Branch, C.E., Trentham, L., Robertson, B.T. and Beckett, S.D. 1990. "A comparison of interactive videodisc instruction with live animal laboratories." *American Journal of Physiology* 259 (Adv. Physiol. Educ. 4): S11-S14.

*In this study involving 85 first-year veterinary students, use of interactive videosdisc simulations yielded equivalent test performance and greater time-efficiency in teaching cardiovascular physiology than did a live-animal laboratory.*

Greenfield, C.L., Johnson, A.L., Schaeffer, D.J. and Hungerford, L.L. 1994. "Comparison of surgical skills of students trained with models or live animals." *Journal of the American Veterinary Medical Association* [submitted].

*Surgical skills of 36 third-year veterinary students were evaluated following training of one group with dogs and cats, and the second group with soft-tissue organ models. The performance of both groups was equivalent.*

Guy, J.F. and Frisby, A.J. 1992. "Using interactive videodiscs to teach gross anatomy to undergraduates at The Ohio State University." *Academic Medicine* 67: 132-133.

*In this study involving a total of 473 prenursing and premedical students, the test performances of those using computers (interactive videodiscs) were equivalent to those of students in traditional cadaver-demonstration labs.*

Jones, N.A. Olafson, R.P. and Sutin, J. 1978. "Evaluation of a gross anatomy program without dissection." *Journal of Medical Education* 53:198-205.

*Learning performances of approximately 100 freshmen Emory University medical students using films, computer-assisted instruction, and prosected human cadavers were equivalent to those of students taught using a traditional lecture/dissection program.*

Lieb, M.J. 1985. "Dissection: A valuable motivational tool or a trauma to the high school student?" Thesis, Master of Education, National College of Education, Evanston, Illinois.

*The author found no difference in post-test scores of students who dissected worms versus those who received a classroom lecture on worm anatomy.*

McCollum, T.L. 1987. "The effect of animal dissections on student acquisition of knowledge of and attitudes toward the animals dissected." Doctoral dissertation, University of Cincinnati.

*This study involved 350 high school biology students, half of whom were taught frog structure, function, and adaptation via lecture, the other half via frog dissection. Overall, students taught by lecture performed better on a follow-up test than did those taught by dissection.*

More, D. and Ralph, C.L. 1992. "A test of effectiveness of courseware in a college biology class." *J. Educational Technology Systems* 21: 79-84.

*Half of a class of 184 first-year biology students used traditional hands-on laboratories, while the remainder used computer courseware. Biology knowledge of the computer-taught students increased significantly more than did that of the traditional group.*

Phelps, John L.; Hosemann, Sunni; and Abedor, Alan J. 1992. "Videodisc emulation of a live animal physiology laboratory." *Journal of Medical Education Technology*, Vol. 2: 12-20.

*Undergraduate nursing and respiratory therapy students who studied using an interactive video program on cardiac output principles performed significantly better on a follow-up test than did a similar group taught with lecture and live-animal physiology laboratory.*

Prentice, E.D., Metcalf, W.K., Quinn, T.H., Sharp, J.G., Jensen, R.H.. and Holyoke, E.A. 1977. "Stereoscopic anatomy: Evaluation of a new teaching system in human gross anatomy." *Journal of Medical Education* 52: 758-763.

*Based on the learning performances of 16 physician's assistant students evaluated at the University of Nebraska Medical Center, the authors concluded that use of labeled sequential slides of anatomical dissections provided a viable alternative to dissection.*

Samsel, R.W., Schmidt, G.A., Hall, J.B., Wood, L.D.H., Shroff, S.G., and Schumacker, P.T. 1994. "Cardiovascular physiology teaching: Computer simulations vs. animal demonstrations." *Advances in Physiology Education* 11: S36-S46.

*110 medical students used both computer demonstrations and animal (dog) demonstrations, and rated the former higher for teaching cardiovascular physiology.*

Strauss, R.T., and Kinzie, M.B. 1994. "Student achievement and attitudes in a pilot study comparing an interactive videodisc simulation to conventional dissection." *The American Biology Teacher* 56(7): 398-402.

Two groups of high-school students, totaling 20 in number, attained equivalent results on a test following either animal dissection or interactive videodisc simulation.

## EXPERTS' STATEMENTS ON DISSECTION

During the twentieth century, tens of millions of animals have been killed for use in dissection and various other exercises in colleges, high schools, and even middle and elementary schools. Dissection remains widespread today, but opposition to it has grown in recent years. Many students are now protesting and educators questioning the destruction of life in the name of education, and debate grows over the validity of dissection as part of our education system.

The main issues of this debate are educational worth, alternatives, animal welfare, societal values, and environmental impact. For each, dissection is problematic, as shown in the compilation of statements presented here. They are the words of educators, scientists, and individuals with both the knowledge and experience that qualifies them to comment meaningfully on dissection and other exercises that harm animals in education. Most of these statements are recent, having been made in the late eighties or early nineties. References are available on request.

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### EDUCATIONAL WORTH

*"The suggestion that a surgeon is somehow better because he or she was trained on animals in medical school or in undergraduate biology or physiology or anatomy, let alone by dissection of frogs in high school, is totally unfounded."*

Donald E. Doyle, M.D., surgeon

*"From the prespective of a physician involved in clinical practice, education and research, I have come to the conclusion that killing and dissecting animals is not only unnecessary but also counterproductive in the training of physicians and scientists."*

David O. Wiebers, M.D., neurologist

*"The U.S. is suffering from a crisis in science education. Those who say that stopping dissection in schools will damage the quality of education are at best naive. At worst, they are deliberately distracting us from the real problems such as illiteracy and innumeracy.*

Charles Hsu, Ph.D., geneticist

*"I seriously question that any successful scientist or doctor can attribute his or her success to the high school or college dissection experience."*

Suzanne Cliver, D.V.M., veterinarian

*"The often-used excuse that "hands-on" experience is necessary for those wanting to become biologists or medical personnel simply is untrue. The experience of dissection is totally unnecessary for the biologically minded pre-college student."*

Nedim C. Buyukmihci, V.M.D., veterinarian

*"My own experiences as a life sciences student, research assistant, and veterinarian have convinced me that dissection has little relevance to learning about life processes."*

Eric Dunayer, V.M.D., veterinarian

*"It is irreconcilable, having advanced so far in the study of the life sciences, that we are still so delayed in our scientific adolescence regarding the issue of animal dissection. At this late date, we must desist from this archaic and immoral practice."*

Lisa Hara Levin, D.V.M., veterinarian

*"We must stop the ritual of dissecting as a regular part of the biology curriculum. It's not meaningful. It's a waste of our animal resources. It's expensive. And it takes time and attention away from other critical topics in biology."*

David Bates, Oregon's Most Outstanding Biology Teacher, 1990

*"The cause of education would not suffer if the classic dissection of frogs was removed from the high school curriculum."*

Nina J. Haddock, Ph.D., M.Ed., clinical psychologist

### ALTERNATIVES

*"[Dissection] is on the decline—it is old fashioned. It is a responsibility of teachers to move with the times and keep up to date with what to teach. Since there are many good alternatives to dissection, a wise choice would be to use them."*

F. Barbara Orlans, Ph.D., physiologist

*"Year after year, animals are used to demonstrate the same well-known principles, although sophisticated models, videotapes, and computer simulations could easily substitute. These humane alternatives have many advantages, including reusability and durability."*

Eric Dunayer, V.M.D.

*"It was concluded that the interactive videodisc-simulated lab [developed by the authors for studying the cardiovascular system] was as effective as the traditional live-animal labs and was more time efficient than the traditional participation lab."*

A. L. Fawver, D.V.M., et al., 1990,
*American Journal of Physiology*

*"...undergraduate nursing and respiratory therapy students who [completed] an interactive video program on cardiac output principles [performed] significantly better on a learning post-test than a similar group completing a lecture and live-animal physiology laboratory."*

John L. Phelps, Ph.D., health educator

*"Computer-presented tutorial and simulation of biology laboratory concepts proved to be as good as or better than traditional approaches [that consume living or preserved animals] in increasing student academic performance."*

Daniel More, M.S., and Charles L. Ralph, Ph.D. 1993,
*Journal of Educational Technology Systems*

ANIMAL WELFARE

* *"The cats are mercilessly prodded, and jabbed, undoubtedly causing injuries to their eyes, heads and even potentially their internal organs. The... hysteria in these cats, already caged inhumanely, and then jabbed with this lethal metal rod, is quite evident."*

Suzanne Cliver, D.V.M.

* *"The cavalier disregard exhibited towards the lives of... animals destined for our nation's schools and students is in stark contrast to the facade of white coats, gleaming scalpels and scientific principles espoused by the defenders of dissection as a pedagogical tool."*

Stephen Zawistowski, Ph.D., behavioral geneticist

* *"There is no doubt these animals are, at best, severely stressed and terrified, at worst, inhumanely maimed and tortured.... No living being should be subjected to such a cruel and inhumane death."*

Suzanne C. Terrant, D.V.M., veterinarian

*"In my experience, the sickest reptiles and amphibians I have ever seen have come from either fish markets or biological supply companies.... The turtles I worked with from a biological supply company in the northeast were horribly ill with polysystemic disease, probably secondary to inadequate husbandry and chronic starvation."*

Barbara Bonner, D.V.M., veterinarian

*"If every teacher and student considering dissection were to first witness the capture, handling and death of each animal they were about to dissect, dissection would fast become an endangered classroom exercise."*

Jonathan P. Balcombe, Ph.D., ethologist

SOCIETAL VALUES

A. Teaching of Values

*"When a student himself/herself hurts or kills an animal, the experience may be traumatic or emotionally desensitizing. Many high school students cannot bring themselves to harm animals as it is against their natural feelings, and they are seriously troubled over the moral problems involved when others kill living beings."*

F. Barbara Orlans, Ph.D.

*"The psychological effects of vivisection and dissection and invasive animal experimentation on the personality of a young person cannot be overemphasized. In no way does vivisection or dissection make a young person better, more capable, or more humane."*

George K. Russell, Ph.D., biologist

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*these statements were in response to a 1990 undercover investigation of a major US supplier of animals for dissection

*"Carving up a frog doesn't teach a student to think inquisitively; it teaches that living things are just commodities that can be bought and thrown out at the end of class."*

Randall Lockwood, Ph.D., ethologist

*"The student who refuses to participate in an activity which is or appears to be cruel should be encouraged, rather than discouraged. Compassion is far more difficult to teach than anatomy."*

Neal D. Barnard, M.D., psychiatrist

*"By using models and discouraging inhumane and educationally pointless dissection, I feel I am encouraging my students to have a respect for all life, animal and human, that will extend beyond the boundaries of the classroom."*

Dennis R. Boulton, M.S.,
1987 Humane Educator of the Year

*"Taking into account that biology is the science of life, and that it is not coherent to base the teaching of such a science on the death of other beings... [and] giving priority to creation and not to destruction... the ministry resolves to ban vivisection and dissection of animals in all teaching establishments..."*

Argentine Ministry of Education and Justice, 1987

*"Dissection can unintentionally foster fascination for gore and for further unsupervised experiments.... Interactions with animals in school should foster respect for life via caring for animals and observing them in their natural environment, rather than dismemberment of an animal's body."*

Sheila Schwartz, Ed.D., Director,
Humane Education Committee, United Federation of Teachers

*"[The current method for teaching biology] not only fails to promote reverence for life, but encourages the tendency to blaspheme it. Instead of increasing empathy it destroys it. Instead of enlarging our sympathy it hardens the heart."*

Joseph Wood Krutch, naturalist and author

*"The easy availability and nonchalant destruction of these beings desensitizes children to the underlying issues of cruelty and violence towards any life form."*

Suzanne C. Terrant, D.V.M.

*"Interactions with animals in school should foster respect for life via caring for animals and observing them in their natural environment, rather than dismemberment of an animal's body."*

Sheila Schwartz, Ed.D.

*"It is unthinkable to me that... we continue to buy, pith, dissect and discard frogs and their body parts... in the name of science.... We need a comprehensive environmental... attitude which includes all animals in their rightful place in the world. In my opinion their place is not the dissection table."*

Joyce Bloom, Ed.D., educator

**B. Student Needs**

*"Children are naturally inclined not to want to participate in the killing and dissection of live animals. We as a society would be wise to heed and foster such inclinations."*

David O. Wiebers, M.D.

*"Biological science curricula in which dissection of animals is required selects and has selected for a population of students who regard animals as disposable tools. This is probably why many biologists, biology educators, and health care professionals do not even think of considering using methods of teaching and research in which animals are not harmed."*

Gloria J. Binkowski, V.M.D., veterinarian

*"Biology, as it is now conducted, stands to alienate potential students in increasing numbers if instructional methods are not altered or amended. This alienation could result in the loss of talent to scientific fields... since some students may elect to drop out of basic biology rather than dissect."*

Larry M. Brown, M.Ed., educator

*"For many students, dissecting an animal is very upsetting, and all students are disturbed by the experience in one way or another. Learning is difficult under these conditions."*

Neal D. Barnard, M.D.

*"...forcing dissection is not only an improper use of animals; it is also an improper use of students."*

George K. Russell, Ph.D.

*"The major reason given by students for liking this simulation [Interactive Frog Dissection] was their relief at not being required to dissect a frog."*

Richard T. Strauss, Ed.D, and Mable B. Kinzie, Ph.D., 1991
*The American Biology Teacher*

*"... it is inconsistent and improper to require a sincere student to perform dissections when, to that student, doing so violates her principles based on a reverence for all life."*

Donald Emmeluth, D.Ed.
former president, National Association of Biology Teachers

*"Requiring a sincere student to dissect an animal against his/her will is unjust, as would be requiring a vegetarian student to eat meat."*

Jonathan Balcombe, Ph.D.

*"The fact that dissection can and does turn off some talented youngsters from a career in the biological sciences is indisputable."*

F. Barbara Orlans, Ph.D.

*"Casually slicing up animals in junior high and high school fosters callousness, and it certainly doesn't stimulate curiosity. If anything, it turns some bright students off scientific research."*

Charles Hsu, Ph.D.

*"In reality, the lack of respect for living creatures shown by presenting dead [animals] for dissection probably deters more promising students from the "life sciences" than it attracts."*

Suzanne Cliver, D.V.M.

*"No valid educational system should seek, by coercion, conformity or tradition, to blunt students' sensitivity and force them to engage in activities that are contrary to their beliefs."*

Michael W. Fox, Ph.D., D.V.M., ethologist

## ENVIRONMENTAL IMPACT

*"Roughly 3.2 million frogs are destroyed for dissection each year."*

F. Barbara Orlans, Ph.D.

*"The decline in the frog population since 1970 is real and has been recently documented by the Biology Board of the National Research Council. The exact causes, however, have not been determined. Given this decline, regardless of the reasons, removing more frogs for classroom dissection is unjustifiable."*

Suzanne Cliver, D.V.M.

*"I know of several biological supply houses in Louisiana and Mississippi which are notorious for finding a pond and collecting every living thing to be found within it... many of our states' ponds and bogs are devoid of herpetofauna because of this practice."*

Dez R. Crawford, herpetologist

*"Better [instructional] methods exist and should be utilized to [stop] depletion of wild populations, such as crabs, sharks and frogs."*

Evelyn E. Jenkins, D.V.M., veterinarian

*"One must question the wisdom of using formaldehyde-preserved specimens for children's anatomy lessons, since formaldehyde is considered carcinogenic."*

Susan M. Persico, D.V.M., veterinarian

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For more information, contact The Humane Society of the United States, Animal Research Issues, 2100 L Street, NW, Washington, DC 20037, Phone: (301) 258-3046, Fax: (301) 258-3082.

## RESOURCES

*The following materials may be useful in the development and implementation of alternatives to traditional dissection activities. Inclusion of a product or publication on this list, however, does not imply endorsement by The Humane Society of the United States.*

### BOOKS

***Alternatives in Biology Education***, a free booklet containing a number of alternatives to dissection, is available from the Biology Methods Review Project, 333 Washington Street, Suite 850, Boston, MA 02107.

***The Anatomy Coloring Book***, 2nd ed. (1993), by Wynn Kapit and Lawrence Elson, is available through HarperCollins, 1000 Keystone Industrial Park, Scranton, PA 18512. Single copies are available from Science News Books, 1719 N Street, NW, Washington, DC 20036, (800) 544-4565 or (202) 331-9653.

***Biological Science: A Molecular Approach***, 5th ed., by the Biological Sciences Curriculum Study (Lexington, MA: D.C. Heath and Co., 1985). Contains information useful to students interested in producing anatomical overlays or building clay models of frogs.

***Biology***, by P. Alexander, J.J. Bahret, J. Chavez, Gary Courts, and Naomi D'Alessio (Morristown, NJ: Silver Burdett Company, 1986). A good reference for students interested in producing anatomical overlays or building clay models of frogs.

***Biology***, by James E. McLaren and Lissa Rotundo (Lexington, MA: D.C. Heath and Co., 1985). A good resource for students wishing to try "Anatomical Overlays" or "Build a Model" projects.

***The Biology Coloring Book***, by Robert D. Griffin, with illustrations by Cinthea Vadala (New York: HarperPerennial, 1986).

***Biology: The Living Systems***, 4th ed., by Raymond Oram, Paul Hummer, Jr., and Robert C. Smoot (Columbus: Charles E. Merrill Publishing Co., 1983). Contains useful information for students interested in producing anatomical overlays or sculpting clay models of frogs.

***The Body Atlas***, by Steve Parker (New York: Dorling Kindersley, 1993) contains full-color illustrations of human anatomy and physiology.

***The Botany Coloring Book***, by Paul Young, with illustrations by Jacqueline Guiffre, (New York: HarperPerennial, 1982) is a learning aid for the study of plant structure, life history, function, habitat, and adaptation. The book contains 100 learning units and is written for high-school and college-level students.

***Botany Illustrated***, by Janice Glimn-Lacy and Peter B. Kaufman (New York: Chapman & Hale, 1984), includes an introduction to the structure and function of plants, an overview of major plant groups, and a section on flowering plant families.

***Discoveries in Biology: Nondestructive Investigations with Living Animals***, by D.M. Ogilvie and R.H. Stinson (Toronto: Copp Clark Pitman, Ltd., 1992).

***The Endangered Species Handbook*** (1986), by Greta Nilsson, contains numerous nonanimal lab projects. A revised edition will be available in the fall of 1995 through the Animal Welfare Institute, P.O. Box 3650, Washington, DC 20007, (202) 337-2332.

***Eyewitness Books: Skeleton***, by Steve Parker (New York: Alfred A. Knopf, 1988).

***Eyewitness Science: Human Body***, by Steve Parker (New York: Dorling Kindersley, 1993).

***Modern Biology***, by Albert Towle (New York: Holt, Rinehart and Winston, 1989), offers useful information for students interested in producing anatomical overlays or constructing clay models of frogs.

***Responsible Use of Animals in Biology Classrooms, Including Alternatives to Dissection***, is published by the National Association of Biology Teachers. Although the monograph has been withdrawn from circulation, portions of it, along with a list of alternative resources, are available free upon request by writing to NABT, 11250 Roger Bacon Drive #19, Reston, VA 22090, or by calling (703) 471-1134. Also available are an NABT position statement and guidelines regarding the use of live animals in biology classrooms. There is a $4 shipping charge for a package containing all of the aforementioned NABT materials.

***Zoology Coloring Book***, by Lawrence M. Elson (New York: HarperCollins, 1982) is available at bookstores and through HarperCollins, 10 East 53rd Street, New York, NY 10022.

## CATALOGS/TEACHING AIDS

*Numerous nonanimal materials for teaching anatomy and physiology, such as models, films, computer software, and transparencies, are available from most biological supply companies. Some materials contain photographs or video footage of actual dissections and, thus, may not be considered appropriate alternatives by all individuals who object to dissection on ethical grounds. Some materials, though presented as adjuncts or pre-lab instructional materials, can also serve as suitable replacements for dissection.*

***Beyond Dissection**, currently the most comprehensive resource catalog for students seeking alternatives to dissection, is available through the **Ethical Science Education Coalition**, 167 Milk Street #423, Boston, MA 02109-4315, (617) 367-9143 or (860) 872-8877.* Beyond Dissection *offers an annotated list of more than 400 innovative products, including CD-ROMs, slides, videos, reference books, computer software, and models, along with the names and telephone numbers of suppliers, and ordering information. Alternative resources are organized by subject matter, which includes comparative anatomy/physiology, animal organ/system anatomy and physiology, embryology, animal behavior, biotechnology, and alternatives to dissection of 12 animal species, among them frogs, rats, clams, sharks, earthworms, birds, and fetal pigs.*

**A.D.A.M. Software, Inc.**, 1600 Riveredge Parkway, Suite 800, Atlanta, GA 30328, (800) 755-ADAM. Animated Dissection of Anatomy for Medicine (A.D.A.M.) interactive multimedia programs for Macintosh, IBM, and Windows. *A.D.A.M. Essentials* version guides students in advanced biology studies in grades 9-12 through a layer-by-layer dissection of the human anatomy, providing visual and textual information and allowing users to select and explore different anatomical features and systems anteriorly or posteriorly. On-screen puzzles test students' comprehension of anatomical relationships. *A.D.A.M.: The Inside Story* teaches basic human anatomy at a K-8 level, allowing students to investigate anatomical layers, structures, and systems.

**Anatomical Chart Company**, 8221 Kimball Avenue, Skokie, IL 60076, (800) 621-7500. Suppliers of human anatomy and physiology charts, vinyl plastic and rubber models, health/medical training aids, and exercise posters as illustrated resources for noninvasive lab studies of human anatomy and muscle reflexes.

**Armstrong Medical Industries**, 575 Knightsbridge Parkway, P.O. Box 700, Lincolnshire, IL 60069, (800) 323-4220. Anatomical models and charts, as well as emergency medical training aids.

**Britannica Film and Video**, 310 South Michigan Avenue, 6th Floor, Chicago, IL 60604, (800) 554-9862. Films and slides for biology education.

**Cambridge Development Laboratory, Inc.**, 86 West Street, Waltham, MA 02154, (800) 637-0047 or (617) 890-4640. Videos and videodiscs that cover the human circulatory, digestive, endocrine, muscular, nervous, respiratory, and skeletal systems, allowing students to "dissect" the human body. Also available are physiological self-study tools and software for students exploring cardiovascular fitness, renal structure and function, and digestive processes.

**Cell Serv Program**, Center for Advanced Training in Cell and Molecular Biology, McCort-Ward Building, Room #103, The Catholic University of America, Cardinal Station, Washington, DC 20064, (202) 319-6161 or (202) 319-5725. Instructive videos on cytotoxins, cell types and fusion, and kits which provide human and other mammalian cell culture materials for studying tissue culture and in-vitro toxicology.

**Cross Educational Software**, 504 E. Kentucky Avenue, P.O. Box 1536, Ruston, LA 71270, (318) 255-8921. Create-A-Test question files for teachers. Computer-simulated laboratory activities, including dissection of a frog and a lesson on the parts, function, and operation of a compound microscope, with slide-viewing of a paramecium, amoeba, spirogyra, hydra, euglena, and leaf cross-section through both objectives of the microscope. Software is compatible with Apple, IBM, and Macintosh computers.

**Denoyer-Geppert Science Company**, 5225 North Ravenswood Avenue, Chicago, IL 60640, (800) 621-1014. Bullfrog model with more than 175 hand-numbered features and an accompanying key. Human anatomy and physiology models and wall charts, overhead transparency atlases, reference books, and video programs that explore frogs' environmental adaptation, sense organs, locomotion, respiration, metabolic rate, muscle, heart, jaws, teeth, tongue, and eustachian tubes, and offer a regional and systematic approach to frogs' internal organs and systems.

**Edvotek, Inc.**, P.O. Box 1232, West Bethesda, MD 20827, (800) EDVOTEK or (301) 251-5990. Biotechnology training workshops for instructors.

**Films for the Humanities and Sciences**, P.O. Box 2053, Princeton, NJ 08543-2053, (800) 257-5126. Catalogs of videos and videodiscs on the complete human anatomy and physiology, marine biology, plant life, cellular respiration, homeostasis, protein synthesis, evolution, ecology, and other biology-related subjects.

**Instructivision**, 3 Regent Street, Livingston, NJ 07039, (201) 992-9081. *The Frog Inside/Out*, a two-part video that explores internal and external anatomy of a frog, including dissection.

**Intelitool**, P.O. Box 459, Batavia, IL 60510-0459, (800) 227-3805. A computerized approach to physiological self-study, with software for Apple, IBM, and Macintosh computers. "Cardiocomp," for student practice in ECGs, can also be adapted for lessons on EMGs, biofeedback, and the study of the electrical nature of muscles. "Flexicomp" examines the reflex arc in the knee-jerk response and other reflexes. "Spirocomp" aids in the study of respiratory physiology, including the effects of smoking and exercise. "Physiogrip" examines contractile characteristics of human skeletal muscle and includes hands-on participation in lessons on motor point stimulation, muscle contraction, fatigue, and other phenomena.

**Intellimation Library for the Macintosh**, Dept. 5SCH, 130 Cremona Drive, P.O. Box 1922, Santa Barbara, CA 93116-1922, (800) 346-8355 or (805) 968-2291. Higher-education software and multimedia catalog including programs for human anatomy, animal biology, dissection tutorials, and laboratory series.

**Knowledge Adventure**, 4502 Dyer Street, La Crescenta, CA 91214, (800) 542-4240. *3-D Body Adventure* in PC CD-ROM or 3.5" disk version allows point-and-click examination of and general information about human anatomy, organs, and diseases, plus a three-dimensional tour of the human heart and circulatory system.

**Logal Software, Inc.**, P.O. Box 1499, East Arlington, MA 02174-0022, (800) LOGAL-US, or (617) 646-6467. Simulation-based courseware for biology curricula, which enables students to observe and manipulate biological simulations, plan experiments, and draw hypotheses and conclusions. The *Biology Explorer* series includes "Photosynthesis," "Population Ecology," "Genetics," and "Cardiovascular System."

**Media Design Associates**, P.O. Box 3189, Boulder, CO 80307-3189, (800) 228-8854. MS-DOS and Macintosh CD-ROM entitled *Learning All About Dissection*, an interactive investigation into an organism's anatomy, including actual step-by-step dissection of a perch, crayfish, earthwrom, frog, or fetal pig.

**Medical Plastics Laboratory**, P.O. Box 38, Gatesville, TX 76528, (800) 433-5539. Anatomical reproductions, patient simulators, and emergency training aids.

**Modern Biology, Inc.**, 111 North 500 West, West Lafayette, IN 47906, (800) 733-6544. Experiments and lab courses in molecular biology.

**NASCO**, 901 Janesville Avenue, Fort Atkinson, WI 53538, (800) 558-9595. Wide spectrum of science materials for the classroom.

**National Teaching Aids, Inc.**, 1845 Highland Avenue, New Hyde Park, NY, 11040, (516) 326-2555. Science kits, bio-LOGICAL™ models, and hands-on Microslide™ teaching aids (including photomicrographs, teaching guides, reproducible student worksheets, and lesson plans) on hundreds of specific topics involving cells, plants and fungi, animal biology, human biology, metamorphosis, and the biosphere.

**NORINA** (Norwegian Inventory of Audiovisuals), Laboratory Animals Unit, Norwegian College of Veterinary Medicine, P.O. Box 8146 Dep., 0033 Oslo 1, Norway (telephone: +47 22 96 45 74). English-language database of audiovisuals for use in the biological sciences. NORINA database, which gives an overview of more than 1,300 alternatives and supplements to the use of animals, from elementary to university levels, includes advanced-technology computer programs, interactive video and films, as well as the more traditional slide series, three-dimensional models, and classroom charts. Database is compatible with Macintosh and IBM Windows and is also available in a "stand-alone" IBM version that runs on any PC with harddisc, requiring no additional software.

**Optical Data Corp.**, 30 Technology Drive, P.O. Box 4919, Warren, NJ 07059, (800) 524-2481 or (908) 668-0022. Curriculum programs based on media-enhanced instructional strategies, including interactive video/computer biology projects. Videodisc databases for the secondary sciences include surveys of molecular, cell, plant, animal, and human biology, frog anatomy and physiology, life processes at the cellular, species, and ecosystem levels, and human anatomy and physiology.

**Oxford University Press**, 198 Madison Avenue, New York, NY 10016, (800) 334-4249 or (212) 726-6000. Information on a large selection of videos, computer software, books, and journals for higher education and laboratories. For ordering/purchasing, contact the Oxford University Press, 2001 Evans Road, Cary, NC 27513, (800) 451-7556.

**Phipps and Bird, Inc.**, 8741 Landmark Road, P.O. Box 27324, Richmond, VA 23261-7324, (800) 955–7621 or (804) 264-7590. The Bio-Meter is a millivolt amplifier that detects and

displays—visually and audibly—bioelectrical events, such as energy associated with contraction of cardiac and striated muscle. May be used for classroom experiments in heart rate differences by height and gender, effects of exercise and rapid breathing, and determination of mean heartbeat. The Wet Spirometer introduces students to the basics of respiratory physiology through easily conducted experiments in which students are the subjects. Experiments include the measurement of tidal volume, vital capacity, inspiratory and expiratory reserve volumes, and inspiratory capacity. Blood Pressure Experiments Kit provides hands-on experience in using the stethoscope and sphygmomanometer and gives background information on systolic/diastolic blood pressure, hypertension, medical conditions indicated by blood pressure, and the definition, discovery, and calculation of blood pressure.

**Queue, Inc.**, 338 Commerce Drive, Fairfield, CT 06432, (800) 232-2224 or (203) 335-0908. Interactive MS-DOS computer tutorials with in-depth studies of the earthworm, crayfish, fetal pig, frog, and fish, including skeleton, sense organs, brain, appendages, digestive and circulatory systems, habitat, and means of locomotion. May be used in place of dissection. *Note:* Some tutorials contain photographs of actual dissections.

**Sargent Welch Scientific Company**, 911 Commerce Court, Buffalo Grove, IL 60089-2362, (800) 727-4368 or (708) 459-6625. CD-ROMs, videos, diagrams, plastic models of frogs, grasshoppers, worms, and pigs, and Hubbard Scientific Dissectograms™. *Note:* Dissectograms are color photographs of animals in various stages of dissection.

**Scholastic Software**, 2931 E. McCarty Street, Jefferson City, MO 65101, (800) 541-5513 or (314) 636-5271. Educational software, including step-by-step computer-simulated dissection of a frog.

**Softkey International, Inc.**, 450 Franklin Road, Suite 100, Marietta, GA 30067, (800) 227-5609 or (617) 494-1200. *Body Works* CD-ROM for Macintosh or Windows is an interactive three-dimensional learning aid about the human body, with special sections on fitness, nutrition, first aid, and sports injuries.

**Thornton Educational Products Co., Inc.**, P.O. Box 2566, Naples, FL 33939, (800) 648-3726. Life science laboratory equipment and accompanying manual for testing applications to teach human and animal physiology. Laboratory stations with components to perform human electrocardiography (EKG), pulse waveform, blood pressure, respiratory physiology, electroencephalography (EEG), and electromyography (EMG; muscle function) experiments.

**Videodiscovery, Inc.**, 1700 Westlake Avenue North, Suite 600, Seattle, WA 98109-3012, (800) 548-3472 or (206) 285-5400. Interactive video/computer biology programs, including the Bio Sci Videodisc, a comprehensive curriculum that features 6,000 color images, animated sequences, diagrams, and short teaching films, and covers vertebrate organ systems, biodiversity, histology, cytology, behavior, movement, biochemistry, and other biology topics.

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